

What is claimed is:

1 1. An apparatus, comprising
2 a chuck;
3 a plurality of precision ferrules, each having at least one hole therethrough;
4 a plurality of optical fibers;
5 wherein said chuck holds said precision ferrules in an array with hexagonal
6 packing and an end of each of said fibers is bonded within a respective one of said holes.

1 2. The invention as defined in claim 1 wherein said apparatus is optically coupled
2 to a corresponding other hexagonally packed array.

1 3. The invention as defined in claim 2 wherein said other hexagonally packed
2 array is one of the group consisting of a micro electromechanical system (MEMS) having
3 a hexagonal array of micro mirrors, a hexagonally packed array of photo detectors, a
4 hexagonally packed array of light sources.

1 4. The invention as defined in claim 1 wherein said chuck is fabricated to include
2 at least one flexible member.

1 5. The invention as defined in claim 1 wherein said holes of said ferrules have an
2 average deviation from the correct positions of less than 3 μm .

1 6. The invention as defined in claim 1 wherein said holes of said ferrules have a
2 collective displacement of less than 3 μm .

1 7. The invention as defined in claim 1 wherein said holes of said ferrules have an
2 average angular misorientation of 3.9 or less degrees.

1 8. The invention as defined in claim 1 wherein said fibers are bonded within said
2 holes using glue.

1 9. The invention as defined in claim 1 wherein said ferrules are arranged to be
2 perpendicular to a face of said chuck.

1 10. The invention as defined in claim 1 wherein said ferrules are arranged at an
2 angle to a face of said chuck.

1 11. The invention as defined in claim 1 wherein said chuck has a hexagonal
2 opening within which said precision ferrules are held in said array with hexagonal
3 packing.

1 12. The invention as defined in claim 1 wherein at least one of said ferrules has
2 an end with a conical tip.

1 13. The invention as defined in claim 1 wherein at least one hole of said ferrules
2 has at least one conical entrance.

1 14. The invention as defined in claim 1 wherein each of a subset of at least two
2 of said fibers has a terminating end that is substantially flush with one end of the one of
3 said ferrules into which said fiber is inserted, and said terminating end of all of fibers said
4 subset being substantially coplanar.

1 15. The invention as defined in claim 14 wherein at least one of said fibers has a
2 terminating end that not is substantially coplanar with said terminating ends of said
3 subset of said fibers.

1 16. The invention as defined in claim 1 wherein said precision ferrules are at least
2 two millimeters long.

1 17. The invention as defined in claim 1 wherein said precision ferrules are
2 ceramic.

1 18. The invention as defined in claim 1 further comprising at least one additional
2 ferrule wherein the hole of said at least one additional ferrule does not have an optical
3 fiber bonded therein, said hole of said at least one additional ferrule that does not have an
4 optical fiber bonded therein being adapted to align said apparatus to a further device to
5 which said apparatus is coupled.

1 19. The invention as defined in claim 1 further comprising a layer of a non-rigid
2 material interposed between said chuck and said ferrules that abut said chuck, said
3 material being non-rigid with respect to said chuck and said ferrules,

1 20. The invention as defined in claim 19 wherein said non-rigid material is at
2 least one of the group consisting of plastic, polyester, polyimide.

1 21. The invention as defined in claim 1 further comprising at least one additional
2 ferrule that does not contain a fiber end.

1 22. The invention as defined in claim 1 further comprising at least one additional
2 ferrule, said at least one additional ferrule containing an alignment member protruding
3 therefrom.

1 23. The invention as defined in claim 1 further comprising a reinforcing sleeve
2 coupled to said chuck.

1 24. The invention as defined in claim 1 further comprising a reinforcing sleeve
2 integrated with said chuck.

1 25. The invention as defined in claim 1 further comprising glue in the interstices
2 between said ferrules which acts to couple said ferrules to each other.

1 26. The invention as defined in claim 1 wherein a face of said apparatus at which
2 said ends of said fibers protrudes is polished.

1 27. The invention as defined in claim 1 wherein said fibers are cleaved fibers.

1 28. The invention as defined in claim 1 wherein said chuck has mounting holes
2 within it which are adapted for mounting said apparatus to a further device to which said
3 apparatus is coupled.

1 29. A method for making a precision fiber array, the method comprising the steps
2 of:

3 securing a plurality of precision ferrules arranged with hexagonal packing in a
4 chuck, each of said ferrules having at least one hole therethrough;

5 inserting a respective optical fiber end into the hole of each of a plurality of said
6 ferrules; and

7 bonding each of said optical fiber ends to its respective one of said plurality of
8 ferrules.

1 30. The invention as defined in claim 29 wherein said chuck has an interior space
2 in which said ferrules are secured, said securing step further comprising the steps of:

3 heating said chuck to expand its interior space; and

4 inserting said plurality of precision ferrules within said interior space while it is at
5 least somewhat expanded as a result of said heating step.

1 31. The invention as defined in claim 29 further comprising the step of bonding
2 each of said precision ferrules to each other.

1 32. The invention as defined in claim 29 further comprising the steps of:

2 bonding each of said precision ferrules to each other; and

3 removing said chuck.

1 33. The invention as defined in claim 29 further comprising the step of polishing
2 said optical fiber ends.

1 34. The invention as defined in claim 29 further comprising the step of aligning
2 said optical fiber ends with an optical flat prior to performing said bonding step.

1 35. The invention as defined in claim 29 further comprising the step of coupling a
2 reinforcing ring to said chuck.

1 36. The invention as defined in claim 29 further comprising the steps of:
2 securing in said chuck at least one additional precision ferrule having at least one
3 hole therethrough; and
4 bonding an alignment member into said at least one hole of said at least one
5 additional ferrule so that a portion of said alignment member protrudes from said at least
6 one hole of said at least one additional ferrule.

1 37. The invention as defined in claim 29 further comprising the step of securing
2 in said chuck at least one additional precision ferrule having at least one hole
3 therethrough into which one of said fiber ends is not inserted.

1 38. An apparatus, comprising:
2 a plurality of precision ferrules tightly held together to form an array with
3 hexagonal packing, each of said ferrules having at least one hole therethrough; and
4 at least two optical fiber ends being bonded within the holes of respective ones of
5 said ferrules.

1 39. The invention as defined in claim 38 wherein said precision ferrules are held
2 together by glue.

1 40. The invention as defined in claim 38 wherein said precision ferrules are held
2 together by a chuck.

1 41. The invention as defined in claim 38 wherein said apparatus is arranged so
2 that said optical fiber ends are pointing in substantially exactly the same direction.

1 42. The invention as defined in claim 38 further comprising at least one
2 additional ferrule having at least one hole therethrough, wherein said hole of said at least
3 one additional ferrule does not have an optical fiber end bonded therein, said hole of said
4 ferrule that does not have an optical fiber end bonded therein being adapted to align said
5 apparatus to a further device to which said apparatus is coupled.

1 43. The invention as defined in claim 38 further comprising at least one
2 additional ferrule having at least one hole therethrough, wherein said hole of said at least
3 one additional ferrule has an alignment member bonded therein and protruding therefrom
4 so as to be adapted to align said apparatus to a further device to which said apparatus is
5 coupled.

1 44. The invention as defined in claim 38 further comprising at least one
2 additional ferrule having at least one hole therethrough, wherein said hole of said at least
3 one additional ferrule is adapted to receive an alignment member whereby said apparatus
4 is aligned to a further device to which said apparatus is coupled.